Journal of Physics D: Applied Physics 2013 vol.46 N14

Plasmonic optical antenna design for performing tip-enhanced Raman spectroscopy and microscopy

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Abstract

This paper highlights optical plasmonic antennas designed with dc-pulsed low-voltage electrochemical etching of a gold wire for implementing tip-enhanced Raman scattering (TERS) measurements. We demonstrate a versatile electrochemical system that allows one to engineer TERS-active metallic gold tips with diverse shapes and sizes in a highly reproducible fashion. The underlying etching mechanism at a voltage-driven meniscus around a gold wire immersed into an electrolyte is discussed in detail. We show that the developed method is suitable to produce not only the simplest geometries such as cones and spheroids, but more complex designs. Attempts have been made to design plasmonic tapered antennas with quasi-uniformly spaced nano-sized bumps on the mesoscopic zone for the extra surface plasmon-light coupling. The capability of the patterned antenna to enhance and localize optical fields is demonstrated with near-field Raman microscopy and spectroscopy of single-walled carbon nanotubes bundles.

http://dx.doi.org/10.1088/0022-3727/46/14/145501